LONGITUDINAL POLARIZATION OF Λ AND $\bar{\Lambda}$ HYPERONS IN DEEP-INELASTIC SCATTERING AT COMPASS.

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The study of longitudinal polarization of Λ ($\bar{\Lambda}$) hyperons in deep-inelastic scattering is important because it can provide an information on the fundamental properties of the nucleon, such as polarization of the strange quarks in the nucleon and to determine the mechanism of spin transfer from polarized quark to a polarized baryon. The production of Λ and $\bar{\Lambda}$ by polarized μ^+ of 160 GeV/c on a polarized ^{6}LiD target has been studied using the COMPASS spectrometer. An important feature of the COMPASS experimental data sample is a large number of $\bar{\Lambda}$ hyperons, which is comparable with number of Λ. First preliminary results on the longitudinal polarization of Λ and $\bar{\Lambda}$ hyperons produced in the deep-inelastic scattering will be presented for 2002 data set.

Measurements of Λ polarization in target fragmentation region provide important information on the fundamental properties of the nucleon such as the role of the $\bar{s}s$ pairs in the proton wave function [1]. The polarized nucleon intrinsic strangeness model [2,3] predicts negative longitudinal polarization of Λ hyperons produced in target fragmentation region. The measurement of the Λ polarization in the current fragmentation region allows to investigate another phenomenon, namely the spin transfer from polarized quark to a polarized baryon. Recent theoretical models of Λ polarization in DIS can be found in Refs. 4–8. Another interesting topic is study of possible quark-antiquark asymmetries either in the quark to Λ fragmentation functions and/or in the quark and antiquark distributions of the target nucleon. Calculations from model [8] show that spin transfer to Λ and $\bar{\Lambda}$ should be the same if standard quark distributions $s(x) = \bar{s}(x)$ are used. However there are difficulties in the interpretation of the results due to large contribution from the diquark fragmentation [3] and significant fraction of Λ hyperons

Table 1. Summary of experimental measurements of Λ hyperon polarization in DIS. Sign of polarization is given with respect to virtual photon momentum.

Reaction Exp.	$< E_b >$ (GeV)	x_F	N_Λ	P_Λ	$N_{\bar{\Lambda}}$	$P_{\bar{\Lambda}}$
$\bar{\nu_\mu} Ne$	40	$x_F < 0$	403	-0.63 ± 0.13		
WA59[12]		$x_F > 0$	66	-0.11 ± 0.45		
μN	470	$0 < x_F < 0.3$	750	0.42 ± 0.17	650	-0.09 ± 0.20
E665 [13]		$x_F > 0.3$		0.09 ± 0.19		-0.31 ± 0.22
$\nu_\mu N$	43.8	$x_F < 0$	5608	-0.21 ± 0.04	248	0.23 ± 0.20
NOMAD [14]		$x_F > 0$	2479	-0.09 ± 0.06	401	-0.23 ± 0.15
eN	27.5	$x_F > 0$	16900	$\frac{P_\Lambda}{P_B D} =$	2500	
HERMES [15]				0.06 ± 0.09		

produced via decays of heavier hyperons.

The experimental situation of Λ and $\bar{\Lambda}$ production in DIS is summarized in Table 1. One can see that in the target fragmentation region the Λ polarization is negative, the spin transfer for current fragmentation region seems to be small.

COMPASS studies Λ and $\bar{\Lambda}$ production by polarized muons of 160 GeV/c on a polarized ^{6}LiD target. COMPASS spectrometer was constructed in the framework of CERN experiment NA58 [9] . The total amount of collected data during the run in 2002 is about 260 TB, with typical event size of 35 kB. This analysis uses total 2002 statistics obtained from longitudinally polarized target. The data presented here are averaged on target polarization.

Selection criteria of Λ, $\bar{\Lambda}$ and K^0_s (V^0) are the following. The primary vertex should be inside target cells whereas the decay vertex of V^0 must be outside of the target. The angle between vector of V^0 momentum and vector between primary and V^0 vertices should be $\theta_{col} < 0.01$ rad. Cut on transverse momentum of the decay products with respect to the direction of V^0 particle $p_t > 23$ MeV/c was applied to reject e^+e^- pairs from the γ conversion. The standard DIS cut $Q^2 > 1$ (GeV/c)^2 and $0.2 < y < 0.8$ have been used. After background subtraction the experimental sample contains about 8000 Λ and 5000 $\bar{\Lambda}$. COMPASS is able to access mostly current fragmentation region with $< x_F >= 0.2$, $< y >= 0.45$, $< x_{Bj} >= 0.02$ and $< Q^2 >= 2.62$ $(GeV/c)^2$. The mean Λ momentum is 12 GeV/c, while mean decay pion momentum is 2 GeV/c. Λ ($\bar{\Lambda}$) hyperon polarization can be measured via asymmetry in the angular distribution of decay particles in $\Lambda \to p\pi^-$ ($\bar{\Lambda} \to \bar{p}\pi^+$) decays. We determine X-axis along the direction of the virtual photon in the V^0 rest frame. The angular distribution in the $\Lambda(\bar{\Lambda})$ rest frame is

$$\frac{dN}{d\cos\theta_X} = \frac{N_{tot}}{2}(1 + \alpha P \cos\theta_X) \qquad (1)$$

where N_{tot} is the total number of events, $\alpha = +(-)0.642 \pm 0.013$ is $\Lambda(\bar{\Lambda})$ decay parameter, P is the projection of the polarization vector on the corresponding axis, θ_X is the angle between the direction of the decay particle (proton for Λ, antiproton for $\bar{\Lambda}$) and X-axis. The acceptance correction was determined using unpolarized Monte Carlo simulation. The DIS events are produced by LEPTO 6.5.1 generator [10] and the apparatus is described by a full GEANT 3.21 [11] model.

The analysis was performed slicing each angular distribution in 10 bins and fitting the invariant mass distribution of V^0 peak to obtain the number of events in the bin. Corrected angular distributions were fit using equation (1).

Results for longitudinal polarization are $P_{K_s^0} = 0.007 \pm 0.017(stat.)$, $P_\Lambda = 0.03 \pm 0.04(stat.) \pm 0.04(syst.)$ and $P_{\bar{\Lambda}} = -0.11 \pm 0.06(stat.) \pm 0.05(syst.)$. All results were averaged over accessible kinematical region.

Spin transfer variable from beam to Λ was calculated as $S = \frac{P_\Lambda}{P_B D}$, where P_B is beam polarization and $D = (1-(1-y)^2)/(1+(1-y)^2)$ is virtual photon depolarization factor. Spin transfer for world and COMPASS data are presented in Fig. 1 (Λ hyperons) and Fig. 2 (for $\bar{\Lambda}$ hyperons). Only points with $x_F > 0$ are shown. One can see that there is reasonable agreement between COMPASS and world data. There is indication that spin transfer to $\bar{\Lambda}$ is non-zero and might be different from the Λ one.

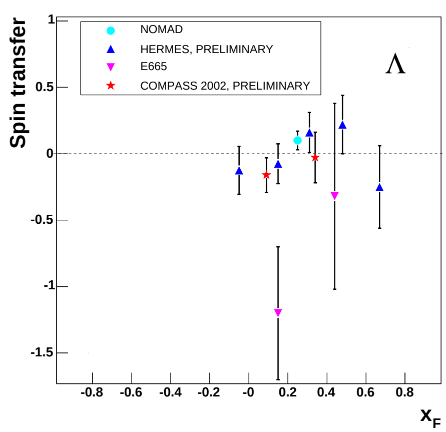

Figure 1. Spin transfer for Λ hyperons.

COMPASS 2002 data show good potential for Λ and $\bar{\Lambda}$ hyperons polar-

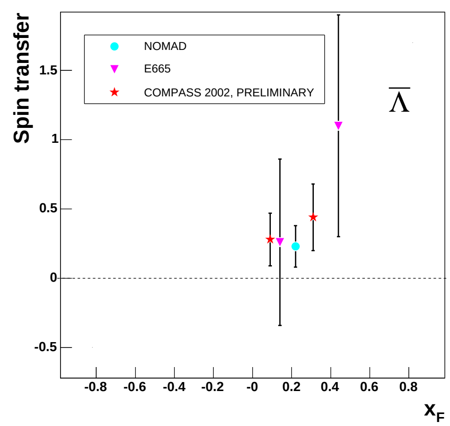

Figure 2. Spin transfer for $\bar{\Lambda}$ hyperons.

ization measurement. Data samples collected in 2003 and 2004 will significantly increase the statistics.

References

1. J.Ellis et al, Phys.Lett., **B353** (1995) 319; Nucl.Phys., **A673** (2000) 256
2. J. Ellis, D. Kharzeev, A.M. Kotzinian, Z.Physik **C69** (1996) 467
3. J. Ellis, A.M. Kotzinian and D.V. Naumov, Eur. Phys. J., **C25** (2002) 603
4. M. Burkardt and R. L. Jaffe, Phys. Rev. Lett. **70** (1993) 2537
5. M. Anselmino, M. Boglione, U. D'Alesio, E. Leader and F. Murgia, Phys. Lett. B **509** (2001) 246,
6. A. M. Kotzinian, A. Bravar and D. von Harrach, Eur. Phys. J. **C2** (1998) 329,
7. C. Boros and L. Zuo-Tang, Phys. Rev. **D57** (1998) 4491.
8. B. Q. Ma, I. Schmidt, J. Soffer and J. J. Yang, Phys. Lett. **B488** (2000) 254
9. A. Bressan, contribution to these proceedings.
10. G. Ingelman, A. Edin and J. Rathsman Comp. Phys. Comm. **101** (1997) 108
11. GEANT, CERN Program Library Long Writeup W5013
12. Willocq S. *et al.* [WA59 Collaboration], Z.Phys. **C53**, (1992) 207
13. M. R. Adams *et al.* [E665 Collaboration], Eur. Phys. J. **C17** (2000) 263
14. P. Astier *et al.*, [NOMAD Collaboration], Nucl. Phys. **B588** (2000) 3; P. Astier *et al.* [NOMAD Collaboration], Nucl. Phys. **B605** (2001) 3
15. A. Airapetian *et al.* [HERMES Collaboration], Phys. Rev. **B64** (2001) 112005 S. Belostotski, talk at this conference.